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DEFENSE SYSTEMS MANAGEMENT COLLEGE



PROGRAM MANAGEMENT COURSE INDIVIDUAL STUDY PROGRAM

MIL-STD-1567 (USAF): IS THERE A
BILLION DOLLAR PAYOFF AND CAN IT BE
REALIZED?

STUDY PROJECT REPORT
PMC 77-2

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE:

MIL-STD-1567 (USAF): Is there a billion dollar payoff and can it be realized?

STUDY PROJECT GOALS:

To document developmental and implementation efforts to date. To better understand contractor and Air Force program office attitudes toward MIL-STD-1567 (USAF) in order to develop appropriate implementation actions.

STUDY REPORT ABSTRACT:

MIL-STD-1567 (USAF), Work Measurement, evolved from a series of studies expressing concern for the economy and efficiency of manufacturing operations of contractors on major Air Force weapon system acquisitions. The MIL-STD establishes requirements for a disciplined work measurement system as a way to achieve productivity improvements. The MIL-STD has created some controversy and some resistance by Air Force program office and contractor personnel. This study examines those program office and contractor attitudes and the results of the implementation efforts to date. Inferences for future implementation and lessons learned are presented.

SUBJECT DESCRIPTORS: Work Measurement, Manufacturing, Production.
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MIL-STD-1567 (USAF): IS THERE A
BILLION DOLLAR PAYOFF AND CAN IT BE
REALIZED?

Study Project Report
Individual Study Program

Defense Systems Management College
Program Management Course
Class 77-2

by

Donald J. Heacox
Major USAF

October 1977

Study Project Advisor
Mr. Wayne J. Schmidt

This study project represents the views, inferences, and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management College or the Department of Defense.

EXECUTIVE SUMMARY

One of the obstacles to effectively implementing MIL-STD-1567 (USAF) has been superficial or inadequate or mis-understanding of work measurement. Rather than exacerbate the situation by trying to distill this complex and sophisticated and important topic into a few fragile apothegms, I would prefer to provide points of contact where one may obtain as much or as little information as required. These are Mr. Don Moore, HQ AFCMD, Autovon 964-4504, and Mr. Leo Baca, HQ AFSC, Autovon 858-7291.

With that caveat, I present the following summary. The use of disciplined work measurement systems provides significant potential cost savings opportunities in the aerospace industry. MIL-STD-1567 (USAF), Work Measurement, was developed to help realize some of those potential savings. The incorporation of MIL-STD-1567 (USAF) has been resisted by contractor and Air Force program office personnel. Advocates of the military standard, by continuing their educational activities and by considering the attitudes of those resisting implementation, may succeed in capturing the savings potential.

ACKNOWLEDGEMENTS, DEDICATION, APOLOGIA

I would like to thank and to recognize those who directly and indirectly, knowingly and unknowingly, helped me with this paper: Rachel McNabb, Leo Baca, Don Moore, Ed Kindinger, Bill Fielder et al and especially all those who responded so well to my letters of inquiry. In addition I wish to thank my study project advisor, Wayne Schmidt.

Much of the background material comes from or is similar to material in my "Improving Aerospace Contractor Productivity through Requiring Disciplined Work Measurements Systems," an unpublished submittal to the 1976 Defense Procurement Research Symposium, and in Don Moore's, "MIL-STD-1567 (USAF): The Billion Dollar Payoff," published in the proceedings of the 1977 Defense Procurement Research Symposium.

I dedicate this paper to Sue, Dana, and Renee Heacox and to Pat Haugh, who - if any single person really wrote MIL-STD-1567 (USAF) - wrote MIL-STD-1567 (USAF).

In writing this paper I tried to be objective. I may, however, not have been entirely successful in shedding my several years experience as an advocate of the military standard. I also recognize that my introducing new material in the "inference" sections of this paper is an academic anathema. However, it seemed necessary to provide greater perspicuity to the inferences and to provide greater insight into the perspective from which the inferences were made.

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INTRODUCTION

Overall Purpose. The overall purpose of this project was to better understand contractor and Air Force program office attitudes toward MIL-STD-1567 (USAF) in order to develop the most appropriate and effective implementation plans.

Specific Purposes. The specific project goals were to document developmental and implementation efforts to date; to identify current contractor and program office attitudes with respect to the military standard; and to suggest future implementation plans.

Organization of this paper with respect to the specific purposes. The documentation of developmental and implementation efforts is contained in the BACKGROUND section and in the RESULTS OF IMPLEMENTATION EFFORTS TO DATE section. The information on current attitudes of contractor and program office personnel is developed from past experiences and from responses to a letter of inquiry sent to eight Air Force program offices, to eight contractors, and to three AFSC product division manufacturing staffs. A copy of the letter of inquiry is provided as attachment 1. Extracts from the responses (7 AF program offices, 3 contractor, 2 product division staffs) and a summary of the responses are contained in the SURVEY LETTER AND RESPONSES section. My overall impression of the current attitudes are provided in the section, AIR FORCE PROGRAM OFFICE AND CONTRACTOR ATTITUDES WITH RESPECT TO IMPLEMENTING MIL-STD-1567 (USAF). My suggestions for future implementation actions as well as some gratuitous lessons learned are provided in the INFERENCE FOR FUTURE IMPLEMENTATION ACTIONS section and in the OTHER INFERENCE AND LESSONS LEARNED section.

BACKGROUND

Evolution of MIL-STD-1567 (USAF)

Many studies of the procurement and production of new weapon systems have been conducted during the last decade. The motivation for these studies has generally been concern over the increasing costs of new weapon systems. The MIL-STD-1567 (USAF), Work Measurement, is but one manifestation of these studies.

Some milestones on the evolutionary path that eventually led to the military standard will be highlighted. In 1970, the Manufacturing Committee of the Aerospace Industries Association conducted a survey from which the following conclusions were made:

"1. Among respondents there is almost universal use of standards for labor planning and control of production labor, and in addition two-thirds of respondents use standards for measuring some portion of the indirect-type or manufacturing support activities. Those who use standards for other than production labor vary widely in the types of activities covered by standards. There appears to be considerably less activity and/or success in measuring indirect labor.

2. Organizational placement appears to have little to do with respect to standards effectiveness as shown by reported savings vs. costs ratios. Among respondents who claim knowledge of their savings vs. costs, ratios vary from 2:1 to over 5:1.

3. Companies with highest savings vs. costs ratios tended to measure by group and also tended to use standard time data.

4. Labor performance reports on a weekly basis are by far most common.

5. Allowances for personal, fatigue and delay time average around 13% with none reported below 5% and none above 22.5%.

6. It is envisioned that in the future standards will be used more extensively for such purposes as computerized shop loading, product and equipment design evaluation, and indirect labor measurement.

7. Standards are normally communicated to supervision and production workers. One-third of the respondents use operator performance to standards for disciplinary action.

8. Seventy-five percent of respondents use electronic data processing terminals for data collection and a like percentage provides for non-productive labor and delay reporting.

9. Among the respondents, about 72% of production labor hours are covered by engineered standards with a marked indication of planned increase of coverage and no planned decrease.

10. Data from respondents indicates that personnel responsible for establishing and maintaining standards systems tend to be somewhat satisfied with current techniques and collectively envision a need for more of the same. This may be an unrealistic approach, particularly with the low production quantities associated with most current aerospace programs." (1)

The Lyon's (for then Brigadier General Herbert A. Lyon, Deputy Chief of Staff, Systems, Air Force Systems Command, Study Director) Study, formally known as the Air Force Production Management Study, was also conducted in 1970. One of that study's conclusions and recommendations was, "Contractual instruments have not contained definitized requirements for effective control of the production process." (2)

As the result of the Lyon's Study, MIL-STD-1528 (USAF), Production Management, was created. One unelaborated requirement of this standard was for the "Maintenance of a work measurement program." (3). In addition to incorporating MIL-STD-1528 (USAF), the A-10 contract contained a somewhat more elaborate requirement for work measurement:

"The contractor shall have and use a system of measuring the efficiency of departments engaged in the manufacturing process. He will insure that the system provides this measurement at the lowest available work center permitting compilation of efficiency rating to the department level. Criteria to be used shall include: labor productivity, amount of scrap, amount of re-work, housekeeping record, safety record, amount of waste, amount of machine down time, shop loading record, planning error record, and scheduled job completion record. Contractor shall also insure that accurate labor time standards exist and are used to assess productivity of all departments engaged in the manufacturing process. He will ensure that labor time standards are provided for each operation element of work required of a worker. Variance reports will be issued monthly showing the actual versus standard performance achieved (summation level) at the lowest available work center. Compilation of individual work center variance will be used to gain job and departmental variance data. The labor time standards along with reasonable variance targets will also be available to contractor cost estimating personnel and will form a basis for manufacturing cost estimates. The contractor will ensure that this labor productivity data is provided as an input to the departmental efficiency system. Acceptable variances, in accordance with industry standards, will be set to insure optimum labor productivity at all levels or departments engaged in the manufacturing process. The contractor shall use this information to most efficiently

manage and control the manufacturing departments. The system procedures, and any subsequent changes shall be coordinated with the local Government representative prior to implementation." (4).

In 1972 the so-called Sagamore Study provided the basis for the statement that even at aircraft 1000, 45% of the time was nonproductive. (5). The study was officially published as the Summary of Air Force/Industry Manufacturing Cost Reduction Study, 28 August - 1 September 1972, Air Force Materials Laboratory Technical Memorandum, AFML-TM-LT-73-1, January 1973. Figure 1 below is reproduced from the study.

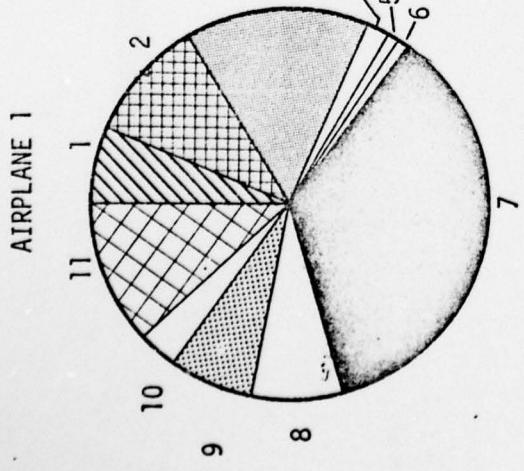
On 25 March 1973, General George Brown, who was then Commander of Air Force Systems Command, chartered Project ACE (for Acquisition Cost Evaluation). (6). One of the results of the project was the identification of an opportunity for potentially significant savings in direct manufacturing labor on major weapon systems, based on the Sagamore Study. Consequently, Air Force Contract Management Division (AFCMD) was tasked to develop a military standard on work measurement. (7). The standard was to be designed to require disciplined and integrated work measurement systems as a vehicle to achieving reductions in direct manufacturing labor and other costs.

The original AFCMD effort, dated 4 January 1974, contained the following provisions that were later modified:

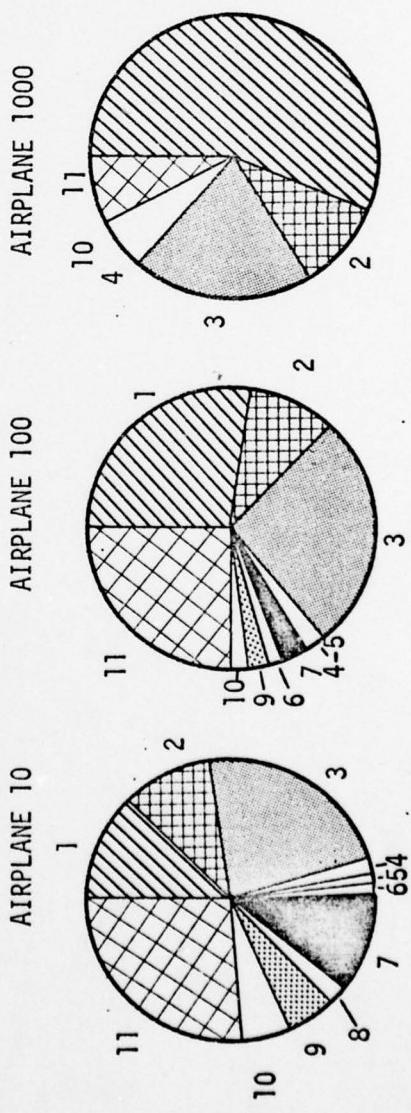
Type I (engineered) standards to have an accuracy of \pm 10% with 95% confidence.

A plan to provide for progress toward a goal of 90% coverage of touch (direct manufacturing) labor by Type 1 standards.

Contractor to take full advantage of the standard time data



6



Note:

- Area 3 - The area of effort that must be worked by mfg R&D & others for cost reduction & must be planned in contracts.
- Area 7 - The area of effort that can be reduced by simple designs.

Figure 1 Man-Hours Expended on a Typical Assembly Distributed to Elements of Cost

available in the DOD Data Bank.

The Government to retain rights to all basic and multi-purpose standard time data developed under contracts of which this standard is a part. (8).

The draft standard was submitted to AFSC by AFCMD and subsequently submitted to industry for coordination. This established a series of interactions ultimately involving AFCMD, AFSC, DOD, and professional and industry association representatives. The objective was to produce a professionally sound, effective, workable standard acceptable to both the Air Force and industry.

The initial industry response came through the Council of Defense and Space Industry Associations (CODSIA). That response is summarized below:

Appreciation of the opportunity to review the proposed standard.

Concurrence with objective of obtaining maximum productivity and cost effectiveness while fulfilling contractual requirements.

Concern that the standard represented another layer of management discipline and control.

Objections that the standard was vaguely specified, structurally complex, extremely burdensome to install and maintain, administratively expensive, redundant to existing contractually required management systems, and contrary to DOD expressed policy.

Emphasis that the proposed standard "would infringe on a private company's right to manage its own business so as to pose a threat to our competitive economic system. Moreover, the imposition of 'socialized' standards on industry would have the effect of stifling competition between companies, contrary to the design to cost concepts and value engineering."

Expression that, "the government's desire for reduced cost can best be attained through contractor competition, not government imposed performance measurement."

Contention that the Project ACE indictment of aerospace industry manufacturing inefficiencies was unwarranted.

Summarization that management techniques must be determined on a case-by-case basis and are best left to the discretion of individual company management.

Emphasis that industry currently uses work measurement.

Contention that current controls are generally adequate.

Recommendation that the standard need not and should not be issued. (9).

The Requirements of MIL-STD-1567 (USAF) and Their Rationale

After revisions and continued AFSC and AFCMD dialog with industry and professional association people, but without their complete agreement, MIL-STD-1567 (USAF), Work Measurement, was published with the date of 30 June 1975. (10). The requirement for use of and references to a DOD Data Bank were deleted. The requirement for government data rights to standards developed in response to the military standard was also deleted. Additional compromises were made in the areas of coverage and accuracy.

The standard was developed to apply to major Air Force weapon system production contracts - those of \$20 million annually or \$100 million total. It was also developed to apply to a full scale development contract of \$100 million or more that was to precede such a major Air Force weapon system production contract. Construction, facilities, off-the-shelf commodity, time and materials, research, study, and development contracts other than those preceding a major production contract were excluded. (10). The standard does not become effective, of course, until incorporated into a contract. The standard was not developed to apply to internal Air Force or DOD activities. The DOD already has a work measurement program. In addition, maintenance and repair activities such as the Air Force Logistics Command, Air Logistics Centers and The Naval Air Rework Facilities have extensive work measurement systems.

The intent of the applicability provision was, of course, to limit the application of the standard to those instances when it would be clearly beneficial.

The standard is also applicable through flow down to certain subcontracts; though flow down may be waived. (10).

The general requirements of the standard are:

- "a. A work measurement plan and supporting procedures.
- "b. A clear designation of the organization and personnel responsibility for the execution of the system.
- "c. A plan to establish and maintain engineered labor standards of known accuracy.
- "d. A plan of continued improved work methods in connection with the established labor standard.
- "e. A defined plan for the use of labor standards as an input to budgeting, estimating, production planning, and 'touch labor' performance evaluation." (10).

The intent is simply for the contractor to have a documented, disciplined, integrated work measurement system.

Certain specific requirements of the standard will be highlighted below. The first of these is for Type I standards to be "backed up by sufficient data to statistically support an accuracy of $\pm 25\%$, with at least a 90% confidence level." (10). This represents a significant compromise from the original position of $\pm 10\%$ with a 95% confidence.

Why an accuracy requirement of $\pm 25\%$ with a 90% confidence level? This is, in fact, a maximum compromise position. The requirement is a minimum common denominator that should be exceeded when warranted. Industry resistance to the accuracy requirement resulted in revision downward of earlier proposed requirements to the $90\% \pm 25\%$ level. There is still some industry suggestion that $90\% \pm 25\%$ as a common denominator is excessively stringent. This appears to be somewhat irrational. Most standards routinely exceed the $90\% \pm 25\%$ requirement. Most standards in commercial industries

without incentives probably exceed $95\% \pm 10\%$. Using time studies, 35 1/2 times fewer observations are needed to demonstrate $90\% \pm 25\%$ as to demonstrate $95\% \pm 5\%$.¹ (11). The appropriate MTM² techniques normally result in an accuracy of $95\% \pm 5\%$. The complexity of the method will determine the number of observations required.

There is also a requirement for the contractor to develop and implement a Work Measurement Coverage Plan which provides a time-phased schedule for achieving 80% coverage of all categories of touch labor by Type I standards." Furthermore this plan "shall be based on cost trade-off analyses which relate savings to be accrued through improved productivity and simplification of work methods to the cost of attaining Type I standards coverage." (10)

$$N^1 = \left(\frac{z}{s} \right)^2 \frac{[N \sum x^2 - (\sum x)^2]}{(\sum x)^2}$$

where:

N^1 = Number of readings required

N = Number of readings taken in the sample

z = The number of standard deviations required based upon the confidence level established by management.

s = Percent accuracy (expressed as a decimal) required as established by management.

x = Each elemental time value.

For 95 ± 5 $z = 1.960$ $s = .05$
For 90 ± 25 $z = 1.645$ $s = .25$

The ratio of N^1 95 ± 5 to N^1 90 ± 25 is 35.49

² Methods Time Measurement is a widely used and accepted set of predetermined time systems. For more information about all the various MTM systems contact MTM Association, Fair Lawn, N.J.

Why 80% coverage? There were three reasons. The first is that according to the Pareto Distribution or ABC Curves, we could expect 20% of the time standards to cover 80% of the direct labor hours. The second is that about 80% coverage of the direct labor hours appears to be a reasonable minimum to give creditability to and promote confidence in a work measurement program. The third reason is that 20% of non-coverage should provide sufficient flexibility by a reasonable margin to accommodate the true anomalies that may not justify engineered time standards. When one looks at the coverage achieved in the commercial market, 20% of non-coverage seems indefensibly high. However, the 80% coverage requirement seems to be a reasonable compromise from the original 90% coverage requirement.

The subject of realization factors and their use is complex and some discussion is needed to understand the military standard requirement in that area.

Simply stated, standards are often adjusted by a variety of factors for a variety of uses for a variety of reasons. The result of this process can promote or denigrate effectiveness. If, for example, one estimates using standards modified by a realization factor based on experience, then the standards can become irrelevant. Philosophically (but not mathematically), this can be expressed by:

$$\text{Estimate} = \text{Standards} \times \text{Realization Factor} = \text{Standards} \times \frac{\text{Actuals}}{\text{Standards}}$$

In other cases, for performance measurement, targets are created by assuming standards will be achieved (100% efficiency) at specific unit of production, say 1000. The standards are then adjusted up a learning curve, for example 84%. Thus the performance target for unit 1 would then be the

reciprocal of the unit value for 1000 on the 84% curve (1/.17594774) or 5.6835 times the standard. In some systems even these targets are adjusted further on the basis of past performance to targets. If one allocates and controls budget based on these targets, then managing to budget provides little incentive for efficiency. (12). When standards provide the basis for determining schedules, shop loads, and manpower levels, some factoring is essential to provide realism. Performance, absentee rates, and other considerations must be made. In these instances the use of realization factors is beneficial. The military standard requires: "when labor standards have been modified by realization factors, each element which contributed to the total factor shall be identified. The analysis supporting each element will be available to the Government for review. (10).

The purpose is to assure that such factors are correctly used in estimating. Estimates should not condone or perpetuate past inefficiencies. The idea was to inhibit inflated estimates to have the estimates to standards to compare favorably with the budget targets so that managing to budget can better promote efficiency.

The military standard requires an audit, at least yearly. The exact statement is:

"The contractor shall use an internal review process to monitor the work measurement system. This process shall be so designed that weaknesses or failures of the system are identified and brought to the attention of management to enable timely corrective action. Written procedures will describe the audit techniques to be used in evaluating system compliance." (10).

Why an audit requirement? The rationale was, in short, to help assure system discipline. The Government is not asking to audit the contractor.

The Government is asking the contractor to review himself. The Air Force Contract Management Division views audit as the key to system discipline. Others outside the Air Force express the same opinion. Audit is the key to confidence in the system and the time standards. Demonstrating accuracy and coverage is important not so much for the Air Force as for the contractor. If the contractor's workforce doesn't believe in the standards, the value of those standards will be largely lost.

The audit is required by the MIL-STD to be of specified scope. That scope includes all of the aspects of the work measurement system management should be concerned about: accuracy of standards; validity of methods; coverage; effectiveness of standards use in planning, estimating, budgeting, and scheduling; timeliness, accuracy, and traceability of production count reporting; accuracy of performance reports; reasonableness of efficiency goals; and the effectiveness of corrective actions resulting from variance analyses.

The audit reports are required to be available for Government review. This was thought to be the least painful way (for the contractor) to have the Government assess the discipline of the contractor's work measurement system. Though the details of the audit are left to the contractor, AFCMD demonstrated to their own satisfaction that using such techniques as sequential sampling makes auditing coverage and accuracy quite practical and economical.

Work Measurement Benefits and Applications

In discussing the "Evolution of MIL-STD-1567 (USAF)," the conclusions of the 1970 survey by the Manufacturing Committee of the AIA were presented. The inferences of this survey vary significantly, depending, of course, on who is making the inferences. The inferences I drew are: that work measurement in 1970 was a valuable management tool, that the applications of that tool in the aerospace industry were widespread, that the applications of work measurement provided positive returns on investments, and that increased applications were desirable notwithstanding reservations about applying work measurement to low quantity production.

A recent survey of US and Canadian industries reinforces that applications of work measurement are widespread and common place. Also of interest from the survey are the most cited obstacles to increasing applications of work measurement: not enough industrial engineering personnel, the economics and practicality of measurement, and management disinterest. (19).

One additional comment should be made before proceeding to describe the benefits of work measurement. Work measurement has been applied as a management tool for many years. As Joel Borden, Director of the American Institute of Industrial Engineers, Work Measurement and Methods Engineering Division, remarked, the 100th anniversary of Frederick Taylor's development of elemental time study is just four years away. And Taylor only refined techniques that were then over 100 years old. (18). Parenthetically, given the history of the application and acceptance of work measurement, the intensity of the controversy provoked by MIL-STD-1567 (USAF) was somewhat surprising.

The key to the savings created by a disciplined work measurement system is methods. Applying engineered standards to operations specifies directly or indirectly how the operations should be done. Setting standards establishes methods. Right from the start certain efficiencies are engineered in and certain inefficiencies are engineered out.

Engineered time standards provide insurance in two ways. First, they help assure that someone has figured out how to make whatever it is that needs to be made. Second, they help assure that if the method selected does not work well, this will be identified early. In both instances, the insurance is provided by the original baseline - both the methods and times specified. It is sometimes argued that the original baseline is unimportant so long as improvement is measured to it. Experience has shown that it is more true that if the baseline is too high, it is impossible to recover no matter how fast one improves.

Two large commercial aircraft projects were claimed to have sustained a fantastic rate of improvement or learning. This suggests that the aircraft were produced before it was really figured out how to build them efficiently. Both these aircraft programs and their producers experienced some financial difficulty attributable, in part, to the costs of producing the aircraft. Setting standards sets performance targets. Just the act of setting targets improves performance, or so researchers would have us believe. Of course, the more accurate the targets, the greater the confidence of the workers in their realism, the better the performance. Standards can often provide a basis for estimates of greater realism and confidence than other methods. More reliable estimates mean budget targets more directly related to performance targets. Managing to budget then becomes

more meaningful in terms of a tool to improve performance. (12).

The analysis of variances of performance to standards helps focus management attention on those problems of greatest significance. Supervision, methods improvement, and other actions can then address those problems to improve performance. Once again, methods appear. By applying the discipline of methods improvement to those operations identified as most needing attention, improvement becomes routine.

An audit program disciplines the system. This assures that when methods are used other than those on which the standard is based, that one of two things happens. In the case where the method is less efficient than that on which the standard is based, the standard method is enforced. In the case where the method is more efficient, the standard and job instructions are revised to capture the improvements.

There can be, of course, many other benefits from a disciplined work measurement system. In the areas of planning, scheduling, loading, and manpower forecasting knowing how long the work should take is invaluable. Without this information to some reasonable degree of accuracy, several undesirable things often happen. In one case, the estimates are overly conservative. Too many people have too much time to do too little. That not only costs too much, it erodes the ability to perform and to control performance. Taking the time allowed, or in the "Parkinsonian" sense, the work expanding to fill the time available, (13), establishes new norms of acceptable performance. Estimates for future efforts based on the history thus created compound the problem.

Sometimes, inefficiency is created by too many assigned to do a set of tasks and getting in each other's way. In certain cases, this has caused the contractor to fall behind schedule. Ironically, the common response of putting more people on the job exacerbated the problem. Once again, the methods approach integral to work measurement would both help avoid the situation in the first place and result in reducing people getting in each other's way in the second place.

In another case, the schedule targets may be unintentionally inadequate. This can set up a chain of actions. As normally some precautionary pad was included, this pad is removed a step at a time. By the time it is discovered that the pad was inadequate in the first place, it is often too late to take the corrective actions that would have been most effective.

One should not infer that work measurement is a panacea. It is, however, a proven, established technique. A disciplined work measurement program is the heart of effective work planning and control. Work planning and control can be effective without work measurement and can be ineffective with work measurement; however, experience shows the opposite is overwhelming more often the case.

Work Measurement Costs and Limitations

The costs of a work measurement system can be considered in several ways. First, the costs can be considered as a percentage of the total costs of the direct labor being measured. Usually a range of 1 to 4% should bracket the cost of a work measurement program. For an absolutely new program, the range might be as high as 3 - 7%.

Another way to consider the costs of a work measurement system is by the ratio of the number of time study or industrial engineers to the number of direct labor employees measured. A common ratio is 1:100. A ratio of 1:50 may be reasonable for a new system. At least one very mature system for a commercial light plane manufacturer operates at a ratio of about 1:200.

The aforementioned work measurement survey of US and Canadian industries indicated a third way of assessing costs. That way was a ratio of work measurement employees to total direct and indirect employees. For firms with 750 or more total direct and indirect employees, the ratio of total work measurement employees to total direct and indirect employees was generally about 1/100. The ratio of technical work measurement employees to total direct and indirect employees was about 8/1000 for 750 total employees - declining to about 7/1000 for 2750 total employees. (19).

Work measurement is inherently limited by the economics and practicality of measurement. This has meant that for work of few repetitions, the setting of precise standards would not be warranted. Certain types of work make precise measurement challenging - particularly work which is primarily intellectual. Computer applied predetermined time standards and computer applied standard data expand the potential for the practical and

economical application of work measurement.

The aforementioned work measurement survey also cited inadequate numbers of industrial engineers and management disinterest as limiting the application of work measurement. These, however, are not inherent limitations of work measurement.

The numbers of industrial engineers does not appear to me to be a significant constraint, although industrial engineering curricula and interests have not seemed recently to favor work measurement. Though work measurement is the so called cornerstone of industrial engineering, there has appeared to be greater concern with the more "glamorous" aspects such as systems analysis, operations research, and so on.

The problem of management disinterest is more severe, indicated in the following commentary by Mr. William Fielder, Hughes Aircraft Company, Head of Standards Administration;

"Those of us who have experienced some degree of real success in our industry know that the most critical requirement for success is management understanding and commitment. Such understanding and commitment are dependent upon the responsiveness of each work measurement system to the specific conditions which exist, and most importantly, to the specific philosophy of management existing in each application. Without such responsiveness, success is impossible. This is our most consistent experience. Conversely, one approach which has always failed is the arbitrary, external imposition of a system which is contrary to management's philosophy and which is not suited to the specific conditions existing." (24)

The Potential For Net Savings When Applying The Provisions of MIL-STD-1567 (USAF) to Current Major Air Force Contracts

The bottom line is where the benefits exceed the cost. In the aerospace industry, we usually are talking about incremental costs and benefits, as most contractors already have some form of work measurement.

Thus the basic question is how good are the existing systems and how effectively are they used. It should be obvious that the Government perceives serious deficiencies and significant opportunities for economy, in general. This was the reason for existence of MIL-STD- 1567 (USAF) in the first place. Certainly, however, there are contractors whose existing systems are adequate. For those contractors, the implementation of MIL-STD-1567 (USAF) creates few incremental costs or benefits.

The standard is designed to be applied to contractors who already have work measurement systems. Therefore, the extent to which additional costs would be incurred indicates the extent of potential savings. The military standard did not create the need for work measurement. The need for work measurement is inherent in production management. In fact, it is difficult to envision efficient manufacturing without a disciplined work measurement program at the heart of work planning and control.

The magnitude of savings potential from a disciplined, as opposed to undisciplined, system is largely judgmental. There are several specific examples, however, that support a savings potential of from 10 - 20% of the direct labor measured, or more. One contractor revitalized his work measurement system and improved his shop productivity over 10%. The burdened value of the resulting savings was an estimated \$6 million for the first year. Another example is the North Island Naval Air Rework Facility. According

to a GAO study, they improved their direct labor performance by 10 - 15% by converting estimates to engineered standards. The unburdened value of this savings was estimated to be \$3.7 million. In the commercial arena, of course, there are a number of success stories that document savings of that magnitude.

Not only is the magnitude of the amount of savings judgmental, so is the timing of the savings. Some contend that only after the system is revitalized, i.e., after the investment costs have been incurred, do the benefits occur. Then the benefit will eventually offset the investment expenditures and net savings result.

Others contend that the benefits begin immediately, even before significant investment expenditures. The word gets around that what was good enough will no longer be good enough. Performance expectations are raised and an immediate jump in productivity takes place. This was the case in the contractor example above that resulted in the \$6 million savings. Several examples of success stories in commercial firms have demonstrated rapid, if not immediate, pay back of work measurement investments. The examples I am familiar with include cases when an old work measurement system was scrapped entirely and replaced with a new one, usually 4M.¹

¹The reference is to Micro-matic Methods Measurement, a computerized work measurement system based the Methods Time Measurement (MTM-1) predetermined time system.

Generally, it should be safe to suggest that the net savings (if any) resulting from disciplining or revitalizing a work measurement system and the timing of those savings depend on a number of factors. These factors include the adequacy of the existing work measurement system, the effectiveness of employing the system and using data produced by the system, the nature of the effort being measured, the efficacy of the revised work measurement system, and so on.

My personal opinion is that few Defense contractors have truly effective work measurement systems, although there certainly are some. As a result, or maybe even not as a result, there appear to be significant opportunities in manufacturing operations for cost reductions - cost reductions that could result from more disciplined, better employed work measurement systems.

Whether or not there is truly a billion dollar savings potential may be somewhat contentious, however the following scenario is not unreasonable:

"The face value of major AFSC contracts is about \$38 billion. Of these major contracts, the vast majority are for production or full-scale development efforts, certainly \$25 billion or more. Of this \$25 billion, more than 30% represents the burdened value of direct manufacturing. Positive influence on at least two-thirds of this direct manufacturing effort seems feasible. A twenty percent savings or improvement potential still appears reasonable. This would create a savings of ($\$25\text{ B} \times .20 \times .20$) -- at least \$1 billion. . . . In addition, about 40% of the face values are used for procurement. About a five percent savings should be made in these expenditures This 5% savings, which is somewhat understated, would total ($\$25\text{ B} \times .40 \times .05$) -- an additional \$1/2 billion! (22).

RESULTS OF IMPLEMENTATION EFFORTS TO DATE

The bottom line results are outlined below:

There has been a general increase in the awareness of program office and contractor personnel for the need to increase manufacturing productivity and for the role of disciplined work measurement systems in meeting that need.

One contractor voluntarily revitalized his work measurement system consistent with MIL-STD-1567 (USAF). This led to \$6 million savings from improved shop performance over a period of one year.

MIL-STD-1567 (USAF) has been incorporated into four contracts. These are the contracts for the B-1 airframe and B-1 avionics and two contracts for 30mm ammunition for the GAU-8 gun used on the A-10 aircraft.

MIL-STD-1567 (USAF) has been included in RFPs or negotiated for the F101 engine, the GAU-8, MX, NAVSTAR, Maverick, AMST, ALCM, and the Mark 12A.

Efforts to incorporate the requirements of MIL-STD-1567 (USAF) into existing contracts for the F-16 and A-10 have encountered significant resistance.

To achieve the posture above required an enormous effort. The primary advocates of MIL-STD-1567 (USAF) have been the manufacturing operations staff people at AFCMD and at AFSC. These are not the program managers, contracting officers, or contractor representatives. Thus the advocates cannot directly implement MIL-STD-1567 (USAF) by incorporating it into applicable contracts themselves.

The implementation efforts of the advocates has been one of creating an environment which would make such incorporation possible. To overcome the intense initial resistance of industry and the normal reluctance of program offices to change or risk, the advocates informed, indoctrinated, educated, and trained. The advocates embarked on a selling campaign. To promote

understanding, the advocates participated in and/or fostered a number of activities including the following:

Developing a Work Measurement System Evaluation Course by Army Management Engineering Training Agency (AMETA) to teach the Government representatives in plant the techniques necessary to assess work measurement systems, including the compliance of those systems with MIL-STD-1567 (USAF). Thus far, five classes have been taught on an ad hoc basis. About 100 have attended, including nine contractor representatives. Efforts are continuing to get the AMETA course established as a permanent DOD offering.

Participating actively in professional association meetings and conferences. AIIE and the MTM Association have provided forums for MIL-STD-1567 (USAF) presentations, discussions, and debates. AFCMD is an institutional member of the MTM Association and has a licensed MTM instructor who provided selected industrial engineers with certification training.

Writing articles on MIL-STD-1567 (USAF). Articles have appeared in Industrial Engineering, the Defense Management Journal, and the MTM Journal.

Creating a panel on manufacturing as an organizational entity for the Joint Logistics Commanders. This panel is to have a subpanel on work measurement. Thus far these "entities" have not been physically constituted and have not met.

Participating in high level Air Force Systems Command - Industry dialog. MIL-STD-1567 (USAF) has been discussed at manufacturing interface meetings between representatives of industry and AFSC.

SURVEY LETTER AND RESPONSES

To try to get a better idea of exactly what the attitudes of Air Force program office and contractor personnel were, I sent letters of inquiry to selected Air Force program offices and contractors. A copy of this letter is provided as attachment 1. The letter promised that the responses would not be on an attribution basis, in order to increase the potential for candor. Accordingly I will only quote specific extracts and summarize. In drawing inferences later in the paper, I will consider other information in addition to the responses to the letter of inquiry.

The letter requested information in four areas. In essence, these were:

- a. The respondent's work measurement background.
- b. The respondent's attitude (favorable or unfavorable) with respect to incorporating MIL-STD-1567 (USAF) in his contracts.
- c. The respondent's perception of the results (positive or negative) from his (potential) implementation of MIL-STD-1567(USAF).
- d. The respondent's perception of the possibility of realizing the potential (as he perceived it) of MIL-STD-1567 (USAF).

Specific Extracts

Program Offices

. . . . air frame contract[s are] the most fertile area for application as they [are] labor intensive

. . . . do not favor incorporating MIL-STD-1567 (USAF) because it is not a prerequisite to entering production or meeting cost/schedule. The contractor has a system that is adequate to meet in-house budgets . . .

. . . . object [to] incorporating the standard as written . . . would favor a tailored version to utilize existing in-plant management systems . . . realistic benefits (if 1567 is properly applied) should exceed \$50 million.

. . . . are opting against full incorporation, primarily because of cost . . . contractor has quoted exorbitantly high costs for strict implementation . . . already has resources at his control to implement an adequate work measurement system and . . . is attempting to do so within the framework of his established management structure . . . have decided to concentrate on improving the contractor's current work measurement system . . .

. . . . really expect very little results initially . . . contractor presently uses a work measurement system . . . such a [MIL-STD-1567 (USAF)] work measurement system is of considerably more value for a contractor . . . which has absolutely no such system . . .

. . . . the use of disciplined work measurement and methods is definitely needed in all major acquisition efforts . . . work measurement and time standards are counter to the current general trend of relaxing supervision and allowing employees to work at their own pace, discipline themselves, and expect awards . . . Contractors are not anxious to undertake the tasks associated with work measurement and standards as long as the Government will pay for the increased costs under present procedures . . . I foresee an additional cost to the Government . . . as . . with the implementation of C SCSC . . . There is no doubt in my mind that the Air Force has a potential billion dollar savings . . . only a fraction . . . can be realized if the Air Force tackles the problem alone . . . an even greater portion . . . can be achieved if all Government agencies move together to improve labor efficiency based on good earned hourly standards.

I have resisted incorporating MIL-STD-1567 (USAF) in established production contracts [because of] expensive contractor [estimates] and [the fact that] audit reports show no . . . unrealistic standards Much of the Government's bargaining power for incorporating additional standards at a reasonable price is reduced as the production program matures I have a neutral belief at this time as to the potential results of implementation

I favor incorporating MIL- STD-1567 on contract; however, I am a firm advocate of tailoring I have encouraged my contractors and directed by Division Chiefs to tailor standards wherever cost effective while maintaining the integrity of the requirements. . . . I see the following potential results from implementation

(1) Increased awareness of work measurement on the part of the contractor.

(2) Increased visibility by Government personnel of the contractor's work measurement system because of the requirements for back up data on engineered labor standards.

(3) A self-regulating work measurement system because of the contractor internal audit requirement.

(4) More positive corrective action resulting from variance analysis of labor performance reports because of the requirement that the contractor document his corrective action.

Contractors

I have resisted incorporation for the following reasons:

1. It does not recognize alternative approaches or provide flexibility to utilize existing systems.

2. Its provisions are too specific.

3. It does not recognize [non-Government] Customer requirements that would cause duplication. We [are performing on commercial subcontracts] but want and need to maintain common systems [for both the Government and commercial work].

4. MIL-STD-1567 should be rewritten to take into account the varied situations confronting industry and should be tailored to the specific contractor and his environment.

5. The military standard dwells too much on procedure rather than results.

In summary, there is a philosophical difference that I have with the military standard. I have found that if a company has consistent and reasonable standards for measurement and uses them for cost control that by attacking 20% of the variance aggressively, 80% of the cost reduction opportunity is achieved. In the process of this, the standards are at the same time either validated or improved. This approach yields maximum returns for cost reduction investments and avoids the futile documentation of every little variance to standard. I strongly oppose a system that would foster a cost of measurement greater than the realized benefits. To follow the proposed military standard would generate a myriad of written variance analysis reports rather than action oriented review meetings and rapid improvement.

With our favorable experience in the utilization of work measurement, we take exception to MIL-STD-1567 (USAF) for the reason that it mandates a uniform level of achievement; removes management's responsibility for judgment and innovation; and introduces inefficiencies and unnecessary administrative costs MIL-STD-1567 (USAF) will potentially defeat its own purpose by creating a system so cumbersome that it will cease to be an efficient management tool. . . . The potential benefits which have been attributed to the use of disciplined work measurement system are already being enjoyed by both the Government and [my company] it has been my hope that your study would conclude that in many instances the contractor's existing systems of work measurement produce results equivalent to those desired by MIL-STD-1567. Consequently, I would expect that you would recommend that the MIL-STD-1567 be rewritten to simply state what is desired rather than attempting to describe in detail how the MIL-STD's authors believe work measurement should be achieved.

. . . . Many of the requirements of the Military Standard are sound industrial engineering techniques and are common practice in our manufacturing operations. These are: a documented work measurement system; methods improvement; use of standards for estimating, budgeting and production control; establishment of personal fatigue and delay allowance; revision of standards as manufacturing changes occur; and performance reporting and goals.

[continuing] However, we do resist the "increased discipline required by the MIL-STD as not being cost effective. These requirements are: a statistical method of establishing the accuracy of standards; development of schedules for obtaining 80% coverage of all categories of touch labor with engineered standards; establishment of engineered standards of "recognized" accuracy; identification of the elements comprising performance factors; weekly performance reporting and documentation of variance analysis and corrective action necessary to meet performance goals; and the minimum of an annual internal audit of all of the foregoing which is to be available for Government review.

[continuing] Advocates of the MIL-STD contend that the standard only specifies the criteria for acceptance of a work measurement system and not the methods. Experience to date has established that there is such a wide variation in interpretation of the criteria that contractors are apprehensive of implementing costly work measurement methods which may prove to be only temporarily acceptable to Government representatives.

[continuing] One important thing to keep in mind is that even if the basic standards are 100% perfect, there are many imperfections in the actual application of standards primarily because of the costs involved in applying standards at the lowest work element level. This kind of application is only worthwhile in high quantity long run production contracts We feel it is more important to follow what is happening to the actual costs as production gets underway than it is to spend countless hours correcting detailed imperfections in standards accuracy and application.

[continuing] We strongly resist giving "disapproval" authority to individuals outside the company who, with all good intentions, are generally not qualified to make such vital management decisions. . . . Some of the important requirements of MIL-STD-1567 are highly subjective.

[continuing] . . . let me again cite the following additional items which we feel would add to our costs due to the unnecessary imposition of:

1. Voluminous statistical studies which are of extremely questionable value when applied to programs exhibiting (a) high change rates, (b) short life, (c) major transitions in implementation plans, etc.
2. Highly formalized variance analysis and corrective action procedures in all cases where work center performance is deficient to plan.
3. Arbitrary minimum percentage requirements for labor standards coverage irrespective of program type, mix, or maturity.
4. Annual audits to determine statistical accuracy of standards; validity of methods; percentage coverage by type standards; effectiveness of the use of standards for planning, estimating, budgeting, and scheduling; timeliness, accuracy of labor performance reports; reasonableness of corrective action resulting from variance analysis.

[continuing] I would have to say that the installation of a disciplined work measurement system of any kind would be of benefit to a contractor who had none at all. On the other hand, from the point of view of a contractor who has a system that is working for him, the benefits of implementing MIL-STD-1567 (USAF) are negative.

[continuing] . . . We feel that our current work measurement systems meet the intent and spirit of MIL-STD-1567 (USAF) and will be accepted by the Government with very little, if any, change. Examining our current systems is a far superior approach to that of trying to write a rather detailed "how to do it" specification and then beating us into that mold. If the claimed savings potential exists it will be realized by the use of any reasonable work measurement system heartily endorsed and applied by the operating management and not particularly by the incorporation of MIL-STD-1567.

Other (AFSC Product Division Manufacturing staffs)

. . . favor incorporation of MIL-STD-1567 in our contracts subject to the following limitations:

- a. There must be an assurance that the savings benefits will outweigh the inevitable costs cited by the contractor.
- b. A means must be found to invoke work measurement throughout a contractor's facility. To do it on a contract-by-contract basis can cause an unnecessarily heavy burden on individual contracts as they are negotiated.
- c. There is a need for work measurement in many other areas besides direct touch labor.

[continuing] In our particular case . . . I believe the potential results will be positive, subject to the limitations cited above . . . Our experience tells us that on high production programs . . . we gain the most. Conversely, on low production . . . the costs could outweigh the benefits.

. . . we strongly favor incorporating MIL-STD-1567 (USAF) in appropriate contacts since it is an excellent management tool . . . We firmly believe that proper implementation of MIL-STD-1567 (USAF) will accrue significant dollar savings for both government and contractors. However, experience shows that the contractors prefer not to depict their costs that will adversely affect their profit margins. Further, a successful work measurement system improves the effectiveness of a manufacturing organization and enhances its ability to compete for new business. . . . We foresee potential cost improvements not only in direct labor, but more importantly in the . . . indirect labor and the variable portion of overhead costs. Accordingly, no contractor welcomes an outside intrusion into the makeup of his overhead cost factors, especially if it reduces his future negotiation advantages.

[continuing] We feel the problem of gaining acceptance of the objectives of MIL-STD-1567 (USAF) lies in the establishing of goals of mutual value to the government and the contractor. Establishment of mutually agreed to funding criteria (based on the share of potential dollar savings) and guidelines for costs and profit surveillance would assist in removing major roadblocks to implementation of MIL-STD-1567 (USAF). A thorough analysis of the contractors' existing work measurement system and the voids in meeting the goals of MIL-STD-1567 (USAF) must be accomplished to preclude a contractor from establishing a duplicate system just to satisfy the MIL-STD.

Summary Data

Caution is advised in drawing conclusions solely from the summary data for two reasons. First, there were a small number of responses. Second, judgment in categorizing the responses may have unintentionally altered the true attitude of the response.

Air Force Program Offices Seven of eight queried responded. One program office supplied responses from two individuals.

<u>Level of Response</u>	<u>Number of Responses</u>
PM or deputy	3
Directorate	2
Division or lower	2

Background of Respondents/Responsible Program Office Personnel Some responses indicated the backgrounds of several people with manufacturing responsibilities.

<u>Background in Work Management</u>	<u>Number of Responses</u>
Formal education/experience	4
Related education/exposure	2
Advocate initiated training only ¹	5

<u>Attitude Toward Implementation</u>	<u>Number of Responses</u>
Pro	2
Pro with tailoring	3
Neutral	2
Con working to improve system	1
Con	0

¹ AFCMD indoctrination, AFCMD MTM certification training, AMETA course.

Contractor Three of eight queried responded. All letters were addressed by name (as compared to Air Force program office letters which were addressed by the program office symbol). All respondents had extensive background in work measurement. All were in favor of work measurement per se, but against the direct incorporation of MIL-STD-1567 (USAF) in their contracts. Two alternatives to the direct incorporation of MIL-STD-1567 (USAF) as written were suggested: Rate a contractor's work measurement system as part of the source selection process; rewrite MIL-STD-1567 (USAF) such that requirements are stated only in terms of results.

Other Two of three AFSC Product Division manufacturing staffs queried provided substantive responses. In both cases the background included exposure to work measurement and the respondents were in favor of incorporating MIL-STD-1567 (USAF) in contracts where there would be some assurances the savings would outweigh the costs.

AIR FORCE PROGRAM OFFICE AND CONTRACTOR ATTITUDES
WITH RESPECT TO IMPLEMENTATING MIL-STD-1567 (USAF)

Air Force Program Office

The attitudes vary, of course, from program to program. The attitudes are a function of the individual's education and experience in work measurement and of the individual's relationship with contractor personnel.

Generally, as one might reasonably expect, those with a greater work measurement education and orientation tend to favor more strongly MIL-STD-1567 (USAF). Similarly, those whose relationships with their contractors are good and who view their contractors as performing well tend to place less importance in strictly implementing MIL-STD-1567 (USAF).

With the caveats of the preceding paragraph, let me now outline what I perceive to be predominant significant attitudes. This will be judgmental and will not be static. A number of respondents' or responsible program office personnel's primary exposure to work measurement has been a result of MIL-STD-1567 (USAF) activities and of associated informational programs of the developers/advocates of the standard. Examples of such informational programs include AFCMD's indoctrination briefings, MTM-1 certification, and the AMETA course in evaluating contractor work measurement systems. As additional experience is gained, the attitudes will inevitably change somewhat.

Work measurement is viewed as a valuable management tool for cost control.

MIL-STD-1567 (USAF) is regarded as a vehicle with some potential to achieve economies in contractor production.

The tailoring of MIL-STD-1567 (USAF) is deemed desirable, even prerequisite to incorporation into production contracts.

Contractors' existing work measurement systems are of uncertain, but probably adequate, effectiveness.

The potential of MIL-STD-1567 (USAF) to effect significant savings when actually implemented would be inhibited by the following factors: the adequacy of existing work measurement systems, limited production quantities, contractor resistance and implementation costs, the cost, friction and effort associated with placing the MIL-STD on contract over contractor objection.

On balance, the immediate risks of increased costs, friction, and effort and the uncertainty of capturing benefits for the program outweigh the prospects of economies, even significant economies, downstream.

Given that balance of risks and prospects, advocating a compromised or tailored application of MIL-STD-1567 (USAF) - advocating refining existing systems, or maintaining a neutral posture (leaving the responsibility and effort for implementing MIL-STD-1567 (USAF) with AFSC and AFCMD) - all of these are superior to directly working to place MIL-STD-1567 (USAF) on contract.

Caution should be abandoned for enthusiasm only upon additional and demonstrable, relevant evidence.

Contractor

Contractor attitudes vary as much, and probably more so, as those of the Air Force program offices. It is also more difficult to determine what their attitudes really are. Their attitudes seem to be a unique and individualistic blend of apprehension of Government action, concern for preserving their perceived management prerogatives, opportunism to effect competitive advantages or internal changes while subscribing actions to external factors, desire to control documentation and information, confidence, defensiveness, gamesmanship, and sincerity.

Of the contractors I have been exposed to who have vigorously resisted MIL-STD-1567 (USAF), I believe only one to be basically defensive and relatively incompetent. I suspect another. Several contractors' systems essentially comply with MIL-STD-1567 (USAF). Once they understood that fact, they became more acquiescent, if not appreciative. The others, whose systems may not meet the MIL-STD's requirement, seem to be sincere in their criticism of MIL-STD-1567 (USAF), some of which provide opportunities for improving productivity and reducing work measurement system costs.

To amplify on the contractors' sincerity is warranted. It is important to note that they generally believe that they are right. They may not necessarily be right, however, they genuinely believe that to be the case.

Even within a contractor organization, attitudes vary, of course. The industrial engineering community generally favors MIL-STD-1567 (USAF) - it provides a greater sense of immediacy, recognition, and importance for some of their tasks. This notwithstanding, it is no easier to get industrial engineers to agree than other types of engineers.

Thus it is difficult to generalize the attitudes of contractors with any degree of confidence. Therefore, I will, perhaps more appropriately, try to generalize classes of attitudes.

Those who do not actively resist incorporation of MIL-STD-1567 (USAF).

Those who do not resist MIL-STD-1567 (USAF) see some positive opportunities. They view constructive compliance as an opportunity to effect some competitive advantage and to improve internal management. At the same time, their more constructive attitude (from the point of view of an advocate) might enable them greater relative flexibility in meeting the requirements of MIL-STD-1567 (USAF). Several who fall in this category are more aggressive toward cost control than perhaps the average aerospace contractor and also perhaps somewhat "hungrier." In addition, this group also includes those whose work measurement systems basically comply with MIL-STD-1567 (USAF) and who are willing to have that potential compliance tested.

Those who actively resist incorporation of MIL-STD-1567 (USAF).

Generally those who resist MIL-STD-1567 (USAF) see little advantage in complying. On the otherhand, they see several potential disadvantages and are additionally apprehensive of government action. The disadvantages of complying with MIL-STD-1567 (USAF) include the following:

a. Risk of radical change to an existing work measurement system or other system.

Some work measurement systems have some unique feature significantly at variance with "motherhood" industrial engineering. Since MIL-STD-1567 (USAF) is, in essence, motherhood industrial engineering, this could present a significant problem. Illustrative examples would be exotic forms of pace rating; not including personal, fatigue, and delay factors in the standards themselves; and so on. Some contractors do not have adequate systems in other areas that are generally prerequisite of satisfying MIL-STD-1567 (USAF), most especially manhour collection and accounting systems. In these instances risk and uncertainty are intensified. This is especially true if the work measurement efforts of the past have been of limited application.

b. Risk of performance criticism.

If the performance of the work measurement system was significantly different than advertised, the contractor's responsible individuals risk criticism from both Government and their own management officials. Even more so, if the resulting manufacturing performance revealed was perceived to be poor, criticism from both Government and their own management officials is risked. A complicating and disturbing factor is the change and variety of Government officials. The program office, plant representative, and auditor personnel may take varying interpretations of the same results. Furthermore, changes in any of these groups could result in varying interpretations over time.

c. Risk of loss of control over documentation.

There are several aspects of control of documentation that contractors find troublesome. Some associate "discipline" with documentation and are concerned that enormous numbers of reports may be generated which are of little internal or external value. Another concern is that performance data of use to their competitors may find its way into their hands. Another concern is that one contractor's performance may be inappropriately or invalidly compared with that of another. In some cases, changing conditions may make historical comparisons misleading of a contractor with himself. Still another aspect is that as control of detailed information is lost, the manager may lose control of his time and of his initiative. He may have his time and initiative absorbed by responding to second guessers or clarifying data to those for whom the data may be misleading.

d. Risk of loss of management prerogative and innovation.

An extension of the concern that a manager's time may be absorbed by responding to MIL-STD-1567 (USAF) queries is the risk of loss of management prerogative. The manager may become "locked" in the work measurement system. Concentration on the existing (compliant) system may involve significant opportunity costs when one considers alternative and innovative approaches that are or may become available.

e. Risk of the practicality and economy of measurement.

Concern is expressed that the nature of some aerospace work - the limited production quantities and the susceptibility to and probability of change - make work measurement impractical and uneconomical.

INFERENCES FOR FUTURE IMPLEMENTATION ACTIONS

The bottom line of this paper is that future implementation actions must consider the attitudes of Air Force program office and contractor personnel. In addition, implementation actions should also consider some inferences of past efforts to achieve increased contractor productivity.

Historically there has been little natural incentive for contractors to vigorously control costs. The Government emphasis on technical performance, the use of cost type contracts, and the concern that the greater the capability one could maintain that the greater would be the probability of survival of all motivated against vigorous cost control.

The use of contractual incentives to control costs has generally not been effective. The analysis of the results of these contracts do not support the contention they control costs or stimulate profits. (14), (15), (16), (17).

Competition in the aerospace business has not been classical. Generally, aerospace prime contractors try to capture a market based on unique technical excellence or capability. Also the aerospace business has become highly structured. There appear to be barriers to entering and leaving the business. The market does not appear to be sufficiently attractive to induce major new participants. The degree to which the Government absorbs risks and supports the existing large companies helps keep them in business. Market shares for the major primes have not changed significantly over the last decade or so.

Efforts to disengage from contractor surveillance and to relax Governmental quality requirements have generally not been successful. Usually Government scrutiny increased as a result of such experiments. This

may be somewhat contentious, as the AMST effort may show. However, different factors surround that effort than earlier ones. The chief difference is that in the case of AMST, production award remains competitive, in the other instances production award was "secure."

Certain other inferences must also be considered in formulating future courses of actions. These inferences are those that could be made with respect to the results of the efforts to date.

The results of the informational and promotional efforts to date have significantly improved the environment with respect to incorporating MIL-STD-1567 (USAF) into contracts. Program offices receptivity has increased as a function of their understanding. Contractor apprehension has decreased, in some cases, as a function of their understanding.

The expressed or demonstrated persistence of the advocates has resulted in some potentially valuable and significant suggestions and alternatives to improve both productivity and the implementation of MIL-STD-1567 (USAF).

In consideration of all of the above, I offer the following inferences or suggestions with respect to implementing MIL-STD-1567 (USAF).

MIL-STD-1567 (USAF) does offer a potential for significant savings in selected applications.

The implementation of MIL-STD-1567 (USAF) should be pursued.

The informational and promotional efforts of the advocates should be sustained.

The concerns of the Air Force program office and contractors should be confronted, specifically:

To promote understanding of what MIL-STD-1567 (USAF) is, as a meaningful requirement, the essential or core or non-tailorable provisions should be clearly delineated. In addition, the range over which the other provisions can be modified or negotiated should be established. Thus, from the outset, both the Air Force program offices

and the contractors will understand what MIL-STD-1567 (USAF) is. Also, this will minimize the possibility that unmeaningful or trivial or tailored versions of MIL-STD-1567 (USAF) (with the integrity of the requirements compromised) would be incorporated into contracts. The incorporation of such versions of the MIL-STD-1567 would not be cost effective for either the contractor or Government, as there would be no significant savings or benefits to offset the costs that may be incurred.

To promote the effective implementation of MIL-STD-1567 (USAF), criteria should be developed for its application. The criteria should be in terms of the repetitiveness of contractor operations (not just the number of deliverable end items), the effectiveness of the existing work measurement system, the productivity of current manufacturing operations, and other factors.

To promote productivity and innovation, the criteria developed above for requisite work measurement effectiveness and manufacturing operations productivity could be also used as benchmarks for source selection and DSARC II and DSARC III. Contractors demonstrating and continuing to demonstrate requisite effectiveness could validate, in effect, satisfying the requirements of MIL-STD-1567 (USAF). Alternatives to MIL-STD-1567 (USAF) could be proposed and assessed in terms of the results of the work measurement or other system and in terms of contractor productivity.

To promote greater objectivity, a definitive baseline in terms of contractor performance to standards should be established, along with ranges of acceptable effectiveness which relate to the individual contractor's environment. When such baselines cannot be established, those instances should strongly motivate the incorporation of MIL-STD-1567 (USAF) in appropriate contracts.

To promote greater trust and to relieve apprehension, agreements with respect to implementing and administering MIL-STD-1567 (USAF) should be clearly documented. Procedures to protect and control sensitive data should be clearly established and conscientiously enforced.

To reduce the probability of unwarranted burgeoning of paperwork, the Government should assume when practicable the burden of documentation by requiring actions to be documentable rather than formal, written documentation. This would be most appropriate when contractor variance analysis and corrective actions are reported orally in daily or weekly meetings.

To assure the continued or projected effectiveness of MIL-STD-1567 (USAF), a careful audit of costs and savings should be performed periodically. Changes in the MIL-STD-1567 (USAF) could be then made on the basis of those audits.

OTHER INFERENCES AND LESSONS LEARNED

The story of the development and implementation of MIL-STD-1567 (USAF) offers lessons for efforts other than work measurement. This section highlights just a few of these lessons.

The first is that any effective effort to implement change requires a commitment to develop the environment necessary for that change to take place. There is a natural resistance to change. In the area of program management, this natural resistance is intensified by an inherent aversion to risk on the part of the Air Force program offices and by an inherent apprehension of contractors for the impact of increased Government action on their perceived prerogatives.

The second is that tailoring is a threat to the integrity of requirements. While tailoring is desirable to accommodate all legitimate anomalies, persistence is necessary to maintain the integrity and therefore the value of the requirement.

The third is that implementation of controversial ideas is facilitated by dealing with contractors individually and by using professional associations as forums for debate. Trust and understanding are achieved more rapidly one-on-one than institution-to-institution. Greater accommodation on both sides is possible on a case-by-case basis. Incremental implementation is also generally less threatening than a blanket or total imposition of requirements. By using professional associations as media for discussion, the dialog becomes less offensive and more rational. Professional peer pressure speeds the identification and confrontation of the issues of legitimate and reasonable conflict.

The fourth is that MIL-STD-1567 (USAF) might be beneficially applied to programs of the other services, i.e., become a DOD military standard.



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DEFENSE SYSTEMS MANAGEMENT COLLEGE
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REPLY TO

ATTN OF: Major Donald J. Heacox
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SUBJECT: Individual Study Project

(MIL-STD-1567(USAF), Work Measurement: Is There a Billion
Dollar Savings Potential and Can It Be Realized?)

TO:

1. The advocates of MIL-STD-1567(USAF), Work Measurement, claim a significant total savings potential from its implementation. Critics within industry and Government apparently believe the advocates' claims to be contentious. In any event, the reception granted MIL-STD-1567(USAF) has been, at best, mixed.
2. Generally, the use of disciplined work measurement and methods systems - the intent and spirit of MIL-STD-1567(USAF) - has been endorsed. Notwithstanding agreements of principle or philosophy, resistance to incorporating the military standard into applicable production and full scale development contracts has often been vigorously resisted.
3. It appears to me to be important to try to determine if the claimed savings potential exists. If it does, then it would make sense to incorporate MIL-STD-1567(USAF) into applicable contracts. If it does not, then it would make sense to abandon implementation efforts. If realizing the benefits of disciplined work measurement and methods systems requires changes to the standard, requires changes in the implementation practices, or requires approaches significantly different from those currently being attempted - this too should be identified.
4. As a student at the Defense Systems Management College, I am undertaking an Individual Study Project to try to do just that. I wish to survey a sample of major Air Force programs and Air Force contractors to identify why implementation of the Work Measurement Military Standard is resisted or favored. This data will then be analyzed along with existing reference material to develop suggestions for future actions to implement or not to implement MIL-STD-1567(USAF).

ATTACHMENT 1

5. To do this, I respectfully request your cooperation and support to the extent practicable. I would like you to answer four questions for me as candidly as possible. Your answers will be treated on a "not for attribution basis." The totality of answers will be synthesized in the report and I will destroy (or return to you, if you wish) your reply to my request.

6. The questions I wish answered are these:

- a. Briefly, what has been your education, experience, and exposure with respect to work measurement?
- b. For what reasons do you favor or resist incorporating MIL-STD-1567(USAF) in your applicable contracts?
- c. What do you believe the potential results (positive or negative) to be from your implementation of MIL-STD-1567(USAF)?
- d. To what extent do you believe the potential benefits (if any) from the use of disciplined work measurement systems can be realized (or are realizable) by or from implementing MIL-STD-1567(USAF)?

7. A response at your earliest convenience would be appreciated. I would hope to have your reply no later than mid-September, so that I can complete this project in a timely manner.

8. I thank you for any cooperation your time permits. You will be provided a copy of my study.

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References

- (1) Aerospace Industries Association, Manufacturing Committee, Final Report of Project MC-72, Manufacturing Labor Productivity, September 1970.
- (2) Air Force Production Management Study, HQ Air Force Systems Command, United State Air Force, Undated.
- (3) MIL-STD-1528 (USAF), Production Management, 1 Aug 72, p. 7, para 4.1.3.3.8.
- (4) Contract F33657-73-C-0500, Annex A, Production Option Statement of Work 160P09 D301, 10 Oct 72, Amended 6 Dec 72.
- (5) AFML-TM-LT-73-1, January 1973, Air Force Materials Laboratory Technical Memorandum, Summary of Air Force/Industry Manufacturing Cost Reduction Study, 28 August - 1 September 1972, p. 30, Figure B-6.
- (6) Project ACE -- Executive Summary, Report of the Project ACE Workshop, Air Force Systems Command, Andrews AFB, Maryland, 25 June 1973.
- (7) AFSC/CC Ltr, Project ACE Implementation Plan, 2 Aug 73, with 1 Atch, Implementation Plan.
- (8) AFCMD, Draft, Proposed MIL-STD-XXXX, Work Measurement, 4 Jan 74.
- (9) CODSIA Ltr, 29 August 1974, to Colonel Hal L. Fitzpatrick, Director of Development and Production Policy, DCS/Systems, Air Force Systems Command.
- (10) MIL-STD-1567 (USAF), Work Measurement, 30 June 1975.
- (11) United States Army Management Engineering Training Agency, DIMES Analyst Basic Course, Work Measurement, Vol II, Undated, pp. 6-17, 6-18.
- (12) Young, Samuel L., Misapplication of the Learning Curve Concept, The Journal of Industrial Engineering, August 1966, pp. 410-415.
- (13) Parkinson, Northcote C., Professor, Parkinson's Law, Houghton Mifflin Company Boston, The Riverside Press Cambridge, P. 2.
- (14) Logistics Management Institute Report, Task 66-7, An Examination of the Foundations of Incentive Contracting, May 1968, p. 14.
- (15) Belden, David Lee, Defense Procurement Outcomes in the Incentive Contract Environment, Technical Report 69-2, Stanford University 1969.
- (16) Parker, John M. Jr., An examination of Recent Defense Contract Outcomes in the Incentive Environment, Thesis, Graduate Systems Management, Air Force Institute of Technology, September 1971.
- (17) Trimble, Robert F., "Can Contract Methodology Improve Product Reliability?" Defense Management Journal, April 1976, pp. 20-23.

- (18) Borden, Joel, "Director's Message," *AIIE News, Work Measurement Methods Engineering*, Volume XII, Summer 1977.
- (19) Rice, Robert S., "Survey of Work Measurement and Wage Incentives," *Industrial Engineering*, July 77, pp. 18-31.
- (20) Boyer, Charles H. and Donald Heacox, William F. Fielder Jr., Stan Wolfberg, W. E. Selby, Ernie Shaw, H. H. Driesnack, Michael A. Nassr, Richard J. Power, Albert C. Adlfinger, Edward P. Kindinger, "Work Measurement: The Flap over MIL-STD-1567 (USAF)," *Industrial Engineering*, November 1976, pp. 14-25.
- (21) Nassr, Michael A., "MIL-STD-1567 Productivity Growth Through Work Measurement," *Defense Management Journal*, April 1977, pp. 16-20.
- (22) Moore, Don E., "MIL-STD-1567 (USAF): The Billion Dollar Payoff," *Proceedings of the 1977 Defense Procurement Research Symposium*.
- (23) Heacox, Donald J., "Improving Aerospace Contractor Productivity Through Requiring Disciplined Work Measurement Systems," unpublished submittal to the 1976 Defense Procurement Research Symposium.
- (24) Fielder, William F., Jr., and Donald J. Heacox, "The Role of Work Measurement and the Work Measurement Military Standard In Improving Aerospace Productivity," *Presentation to the MTM Association Fall Conference*, October 20, 1976.